

Accident Tolerant Reactor Shutdown for NTP Systems, Phase I

Completed Technology Project (2016 - 2016)

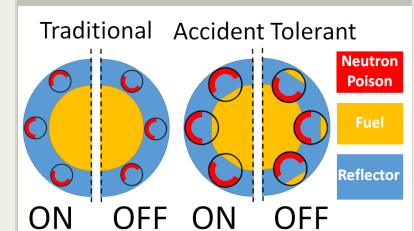


Project Introduction

In this SBIR, USNC will develop an accident tolerant reactor shut-down system for Nuclear Thermal Propulsion (NTP) systems that will guarantee sub-criticality in the event of a water submersion accident. Reactor shut down during a water submersion accident is a crucial issue that must be addressed in NTP systems. The technology that USNC will develop in this SBIR is a low risk design feature that has notable advantages over existing reactor shut-down systems during water submersion accidents. USNC's accident tolerant reactor shut-down system will consist of enhanced control drums with significantly more criticality worth. USNC's enhanced worth control drums are a low risk modification to the traditional control drum where a small amount of fuel is added opposite to the neutron absorber. In addition, USNC's enhanced worth control drums will be moved deeper into the active core to further enhance the criticality worth of the control drums. The combination of adding fuel and moving the drums deeper into the active core will substantially increase the shutdown margin of the control drums and will be sufficient to maintain sub-criticality in the worst case water submersion accidents. Neutronic analysis codes such as MCNP6 and Serpent 2 will be utilized.

Anticipated Benefits

NTP and its supporting technologies have great promise in spreading human presence to Mars and other locations beyond low earth orbit. USNC's accident tolerant reactor shutdown technology will address the water submersion criticality accident for NTP systems and help make NTP a viable technology to fulfill NASA human exploration needs. USNC's work directly aligns with the NASA Technological Roadmap 2015 TA 2: In-Space Propulsion Technologies: 2.2.3 Thermal Propulsion. Currently, NTP is being investigated for a human Mars Mission in the 2030s time frame, but a NTP system would be a game changing technology that would have application for a multitude of missions. In addition, USNC's accident tolerant reactor shutdown technology can be applied to small nuclear systems for space or surface power. These systems, like NTP systems, must also remain sub critical during a water submersion accident. The market for the NTP system and its supporting technologies extends beyond NASA with numerous potential customers in the private industry and defense sector. NTP is a game changing technology that is difficult to quantify in the non-NASA market but has the potential to be very large. USNC is currently pursuing earth based mobile reactors and small modular reactors. These reactors are different than traditional reactors as they can be shipped in whole or modular sections. In the shipment of these reactors it is essential to ensure that they are subcritical during water submersion (much like space reactors). The technology developed in this SBIR may have application in addressing water submersion in these earth-based reactors. In addition, a number of other companies are trying to bring mobile or small modular reactors to the market, creating a clear opportunity to implement the novel technology developed in this SBIR. The market potential



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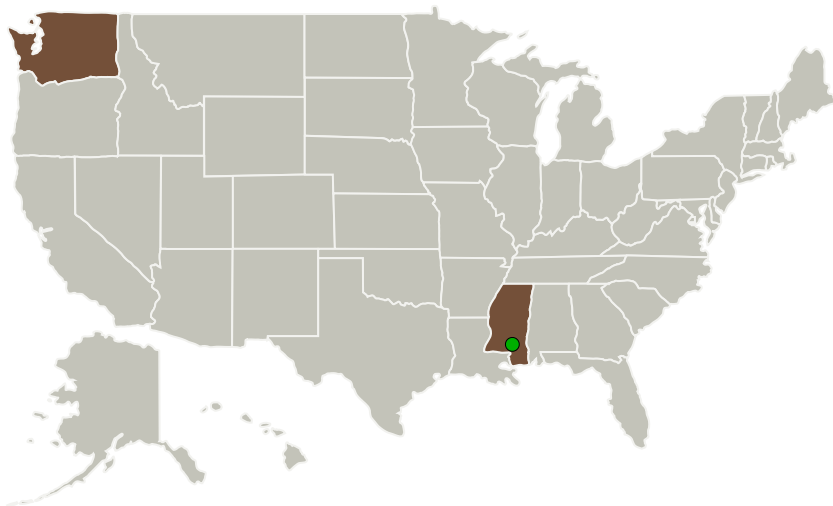
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for advanced reactors is several billions dollars and approximately 40 U.S. companies are trying to bring advanced nuclear technology to the market backed by a total of more than 1.3 billion dollars of private investment.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Ultra Safe Nuclear Corporation	Lead Organization	Industry	Seattle, Washington
● Stennis Space Center(SSC)	Supporting Organization	NASA Center	Stennis Space Center, Mississippi

Primary U.S. Work Locations

Mississippi	Washington
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Project Transitions

**June 2016:** Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Ultra Safe Nuclear Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Managers:Richard T Rauch
Thomas M Stanley**Principal Investigator:**

Paolo F Venneri

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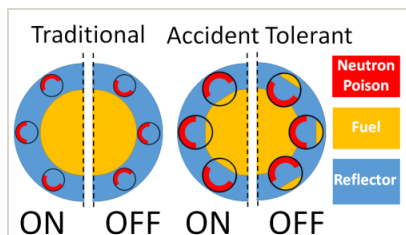
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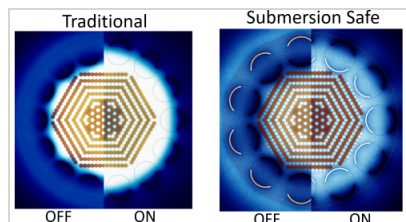
✓ **December 2016:** Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/139893>)

Images**Briefing Chart Image**

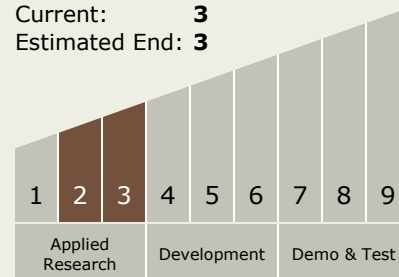
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(<https://techport.nasa.gov/image/128863>)

**Final Summary Chart Image**

Accident Tolerant Reactor Shutdown for NTP Systems, Phase I
Project Image
(<https://techport.nasa.gov/image/133957>)

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**

**Target Destinations**

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System